

REMARKS

Reconsideration of the application is respectfully requested for the following reasons:

1. Formalities

The specification has been amended to include reference numerals 31 and 32, thereby overcoming the objection to the drawings under 37 CFR §1.84(p)(5) set forth on page 2 of the Official Action.

In addition, the claims have been amended to correct minor grammatical errors and to include a recitation that the removal of the oxidized portion of the plug reduces the upper surface area of the plug, which is the main objective of the invention, and which is described for example in **lines 8-15 on page 5** of the original specification, as well as illustrated in **Figs. 2c and 2d** of the original drawings.

Because the changes are all formal in nature and clearly supported by the original disclosure, it is respectfully submitted that the changes do **not** involve **new matter**.

2. Rejection of Claims 1-4 and 6 Under 35 USC §102(e) in view of U.S. Patent No. 6,696,355 (Dennison)

This rejection is respectfully traversed on the grounds that the Dennison patent does not disclose or suggest the steps, positively recited in claims 1 and 4, and illustrated in Figs. 2c and 2d, of:

- oxidizing an exposed area of a plug formed in a contact window of a semiconductor device; and
- removing the oxidized portion of the plug to reduce the upper surface area of the plug.

Instead, the Dennison patent discloses a process for increasing the resistivity of an upper section of the lower electrode of a semiconductor device by various processes involving performing a thermal treatment in an oxidizing atmosphere. According to the Examiner, these processes correspond to the claimed oxidation and removal steps. However, the process shown in Fig. 12A, which involves thermal treatment in an oxidizing atmosphere, is alternative to and not in addition to, the process shown in Fig. 12B, which involves etching. The Dennison patent does not disclose oxidation of a contact structure followed by removal of the oxidized portion, as claimed.

In the embodiment illustrated in **Fig. 12A** of Dennison, the result of the thermal treatment is a husk 233 of substantially dielectric tantalum oxynitride formed on the upper section 232 of a metal compound film or a refractory metal compound film such as tantalum nitride. This husk is substantially non-conducting, and therefore cannot form a contact structure, as claimed. **To the contrary**, the objective of the treatment is to form an area of increase resistivity. This increased resistivity section, in the form of husk 233, is the intended end product of the process of Dennison, and is not removed. There is thus no suggestion of removing the husk 233 to reduce the surface area of upper section 232, and therefore no step that could possibly correspond to the claimed oxidized portion removal step. What appears in the drawing as a reduced area portion is actually a transition section 236 where the upper section 232 is transitioning from a substantially unoxidized core 232.

On the other hand, in the alternative embodiment illustrated in **Fig. 12B** of Dennison, the resistivity of the upper section 232 is increased by etching, which decreases the surface area and therefore increases resistivity. In this embodiment, no structure equivalent to husk 233 is formed. The Examiner will note that Fig. 12B is directed to “another method of increasing resistivity of upper section 232” (col. 7, lines 59-60 of the Dennison patent) and not to a continuation of the thermal treatment process illustrated in Fig. 12A.

Essentially, the Dennison patent teaches alternative methods of increasing the resistivity of an insulating portion of an electrode structure by either (i) forming a high resistivity “husk” 233 which is not to be removed, as illustrated in Fig. 12A, or (ii) reducing the size of the insulating portion, as illustrated in Fig. 12B. Neither of these methods corresponds to the claimed method of reducing the upper surface area of a bit line contact structure by oxidization of an exposed portion of the contact structure, followed by removal of the oxidized portion. The purpose of the present invention is not to increase resistivity, as in Dennison, but to the contrary to ensure good contact between the contact structure or “plug” and the bit line, while decreasing the possibility of shorts due to misalignment.

Since the Dennison patent fails to disclose or suggest the combination of steps recited in claims 1 and 4, withdrawal of the rejection of claims 1-4 and 6 under 35 USC §102(e) is respectfully requested.

3. Rejection of Claims 5, 7, and 8 Under 35 USC §103(a) in view of U.S. Patent Nos. 6,696,355 (Dennison) and 5,795,823 (Avanzino)

This rejection is respectfully traversed on the grounds that the Avanzino patent, like the Dennison patent, does not disclose or suggest the steps of:

- oxidizing an exposed area of a plug formed in a contact window of a semiconductor device; and
- removing the oxidized portion of the plug to reduce the upper surface area of the plug.

Furthermore, the Avanzino patent fails to disclose or suggest even the features specifically recited in claim 5, 7, and 8, namely forming dielectric layers on top of the plug, forming a trench therein, and filling the trench with metal.

According to the claimed invention, bit lines are formed in trenches on top of the contact structure that includes the plug, as Figs. 2e to 2g. The Avanzino patent, on the other hand, discloses forming a via 61 on top of a conductive line 51, after the conductive line has already

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been formed. This is exactly the opposite of the structure disclosed in the present application. While it is true that forming bit lines by etching dielectric layers and filling the resulting trenches with metal is known, it is not known to do so in connection with the claimed steps of reducing the surface area of the plug on which the bit line is formed in order to reduce the surface area of the plug, by oxidizing a portion of the plug and removing the oxidized portion.

Since the Avanzino patent neither discloses or suggests either reduction in the surface area of a plug of the type claimed, nor formation of a bit line on the top surface thereof, and since the Dennison patent also does not discloses the claimed oxidation and removal steps or bit line formation steps, withdrawal of the rejection of claims 5, 7, and 8 under 35 USC §103(a) is respectfully requested.

Having thus overcome each of the rejections made in the Official Action, expedited passage of the application to issue is requested.

Respectfully submitted,

BACON & THOMAS, PLLC

A handwritten signature in black ink, appearing to read 'B. Urcia', with a long horizontal line extending to the right.

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Date: July 1, 2004

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